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EXAMINER	
MILLER, RYAN J	
ART UNIT	**PAPER NUMBER**
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Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary	Application No. 09/884,355	Applicant(s) ZHANG ET AL.	
	Examiner Ryan J. Miller	Art Unit 2621	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☐ Responsive to communication(s) filed on _____.

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *1-21* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *1,7-10,12,14-16 and 19* is/are rejected.

7)☒ Claim(s) *2-6, 11, 13, 17, 18, 20, and 21* is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☒ The drawing(s) filed on *18 June 2001* is/are: a)☐ accepted or b)☒ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☒ Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08) Paper No(s)/Mail Date 2.
4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____.
5) ☐ Notice of Informal Patent Application (PTO-152)
6) ☐ Other: _____.

DETAILED ACTION

Drawings

1. The drawings are objected to as failing to comply with 37 CFR 1.84(p)(4) because a) reference characters "192" in Fig. 1 and "163" on page 13 of the specification have both been used to designate a camera, b) reference characters "193" in Fig. 1 and "164" on page 13 of the specification have both been used to designate a sequence of images, and c) reference characters "194" in Fig. 1 and "165" on page 13 of the specification have both been used to designate a camera interface. A proposed drawing correction or corrected drawings are required in reply to the Office action to avoid abandonment of the application. The objection to the drawings will not be held in abeyance.

Claim Objections

2. The following quotation of 37 CFR § 1.75(a) is the basis of objection:

> (a) The specification must conclude with a claim particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention or discovery.

3. Claims 1-21 are objected to under 37 CFR § 1.75 as failing to particularly point out and distinctly claim the subject matter which the applicant regards as his invention or discovery.

The claims are replete with antecedent problems. The following objections are merely exemplary of the overall problems with the claims. The examiner requests a complete review of the claim to address additional problems that are not explicitly addressed below.

Regarding claim 1, the claim recites the limitations "the camera pose parameters" in line 2, "the three successive images of each triplet of images" in line 6, and "the camera coordinate system" in line 11. There is insufficient antecedent basis for these limitations in the claims.

Regarding claim 2, the claim recites the limitations "the action" in line 3 and "the sum of squared differences between the image coordinates" in lines 5 and 7. There is insufficient antecedent basis for these limitations in the claims.

Regarding claim 3, the claim recites the limitation "the 3D world coordinates" in lines 3 and 7. There is insufficient antecedent basis for these limitations in the claims.

Regarding claim 5, the claim recites the limitations "the locations of each pair of triple matching points" in line 5 and "the fundamental matrix" in line 6. There is insufficient antecedent basis for these limitations in the claims.

Regarding claim 9, the claim recites the limitation "the camera projection matrix" in lines 1-2 and "the camera coordinate system" in line 12. There is insufficient antecedent basis for these limitations in the claims.

Regarding claim 14, the claim recites the limitation "the camera pose parameters" in line 2 and "the camera coordinate system" in line 8. There is insufficient antecedent basis for these limitations in the claims.

Regarding claim 15, the claim recites the limitation "the camera pose parameters" in lines 1-2 and "the camera coordinate system" in line 7. There is insufficient antecedent basis for these limitations in the claims.

As stated above, these objections are merely exemplary and the examiner requests a complete review of the claims for any additional problems.

Claims 3 and 4 also call for the limitation "of an either triple or dual matching point" in line 2 of each claim. This limitation is grammatically awkward. The examiner suggests amending this limitation to read "of either a triple or dual matching point".

Claims 6-8, 10-13, and 16-21 are objected to as depending from objected to claims.

Claim Rejections - 35 USC § 102

4. The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

> A person shall be entitled to a patent unless –
>
> (e) the invention was described in (1) an application for patent, published under section 122(b), by another filed in the United States before the invention by the applicant for patent or (2) a patent granted on an application for patent by another filed in the United States before the invention by the applicant for patent, except that an international application filed under the treaty defined in section 351(a) shall have the effects for purposes of this subsection of an application filed in the United States only if the international application designated the United States and was published under Article 21(2) of such treaty in the English language.

5. Claims 1, 9, 10, 12, 14-16, and 19 are rejected under 35 U.S.C. 102(e) as being anticipated by Davison et al. (U.S. Patent No. 6,668,082 B1).

As applied to claim 1, Davison et al. disclose a computer-implemented incremental motion estimation process for estimating the camera pose parameters associated with each of a sequence of images of a scene, comprising using a computer to perform the following process actions (see Fig. 1: As can be seen in the figure, CPU 4 is used to perform all of the process actions.): establishing a set of triple matching points that depict the same point in the scene across the three successive images of each triplet of images that can be formed from the sequence (see column 22, lines 39-42: The reference describes that the CPU 4 generates a list of points which are matched across all three images in the triple of images (i.e. establishing a set of triple matching points that depict the same point in the scene across the three successive images of each triplet of images that can be formed from the sequence).); establishing a set of dual matching points that depict the same point in the scene across the latter two images of each triplet of images that can be formed from the sequence (see column 22, lines 39-42: The reference describes that points are established that match between each of the images in a triple

of images. Therefore, these points also match across the latter two images of the triple of images and can be considered dual matching points.); defining the camera coordinate system associated with the first image in the sequence as coinciding with a 3D world coordinate system for the scene depicted in the sequence of images (see column 22, lines 47-51: The reference describes that a coordinate system in mm is established having an origin at the camera optical center (i.e. defining the camera coordinate system) for each of the images in the triple of images. Therefore, it is defined for the first image. The reference also describes that this coordinate system is converted from the pixel coordinate system (i.e. the world coordinate system).); estimating the camera pose parameters associated with the second image in the sequence (see column 23, lines 18-23: The reference describes that the camera transformations (i.e. camera pose parameters) are calculated (i.e. estimated) for the first pair of images and the second pair of images in the sequence. Both the first pair of images and the second pair of images include the second image.); and for each successive triplet of images formable from the sequence starting with the first three images (see column 9, line 67 – column 10, line 1: The reference describes that the processing steps are repeated for the next triple of images.), estimating the camera pose parameters associated with the third image of each triplet from previously-ascertained camera pose parameters associated with the first two images in the triplet, as well as the dual and triple matching points of the triplet (see column 23, lines 18-23: The reference describes that the camera pose parameters (i.e. camera pose parameters) for the second pair of images using information from the first pair of images (i.e. from previously-ascertained camera pose parameters associated with the first two images in the triplet) and the "triple" points (i.e. the dual

and triple matching points of the triplet). The second pair of images includes the third image in the triple of images.).

As applied to claim 9, Davison et al. disclose a local bundling adjustment system for estimating the camera projection matrix associated with each of a sequence of images of a scene, comprising: a general purpose computing device (see Fig. 1: As can be seen in the figure, CPU 4 is used to perform all of the process actions.); a computer program comprising program modules executable by the computing device (see column 6, lines 16-18: The reference describes that operating instructions for the CPU 4 are input from a removable data storage medium using disk drive 8.), wherein the computing device is directed by the program modules of the computer program to, input the sequence of images (see Fig. 1: Reference numeral 12, referring to a camera for inputting a sequence of images.):, identify points in each image in the sequence of images (see column 22, lines 21-26: The reference describes that the CPU generates a list of matched points in each image in the sequence of images.); determine which of the identified points depict the same point of the scene so as to be matching points (see column 22, lines 39-42: The reference describes that the CPU 4 determines a list of points which are matched across all three images in the triple (i.e. determine which of the identified points depict the same point of the scene so as to be matching points).), define the camera coordinate system associated with the first image in the sequence as coinciding with a 3D world coordinate system for the scene depicted in the sequence of images (see column 22, lines 47-51: The reference describes that a coordinate system in mm is established having an origin at the camera optical center (i.e. defining the camera coordinate system) for each of the images in the triple of images. Therefore, it is defined for the first image. The reference also describes that this coordinate system is

converted from the pixel coordinate system (i.e. the world coordinate system).); compute the camera projection matrix associated with the second image in the sequence (see column 23, lines 18-23: The reference describes that the camera transformations (i.e. camera projection matrix) are calculated (i.e. computed) for the first pair of images and the second pair of images in the sequence. Both the first pair of images and the second pair of images include the second image.), and for each successive triplet of images that can be formed from the sequence starting with the first three images (see column 9, line 67 – column 10, line 1: The reference describes that the processing steps are repeated for the next triple of images.), estimate the camera projection matrix of the third image of each triplet from previously-ascertained camera projection matrices associated with the first two images in the triplet as well as points determined to be matching points across all three images of the of the triplet and points determined to be matching points across at least one pair of images in the triplet (see column 23, lines 18-23: The reference describes that the camera pose parameters (i.e. camera projection matrices) for the second pair of images using information from the first pair of images (i.e. from previously-ascertained camera projection matrices associated with the first two images in the triplet) and the "triple" points (i.e. the matching points across all three images of the of the triplet and points determined to be matching points across at least one pair of images in the triplet). The second pair of images includes the third image in the triple of images.).

As applied to claim 10, Davison et al. disclose that the program module for determining which of the identified points depict the same point of the scene so as to be matching points comprises sub-modules for: establishing a set of triple matching points that depict the same point in the scene across the three successive images of each triplet of images that can be formed from

the sequence (see column 22, lines 39-42: The reference describes that the CPU 4 generates a list of points which are matched across all three images in the triple of images (i.e. establishing a set of triple matching points that depict the same point in the scene across the three successive images of each triplet of images that can be formed from the sequence).); and establishing a set of dual matching points that depict the same point in the scene across the latter two images of each triplet of images that can be formed from the sequence (see column 22, lines 39-42: The reference describes that points are established that match between each of the images in a triple of images. Therefore, these points also match across the latter two images of the triple of images and can be considered dual matching points.).

As applied to claim 12, Davison et al. disclose that the program module for determining which of the identified points depict the same point of the scene so as to be matching points comprises sub-modules for: establishing a set of triple matching points that depict the same point in the scene across the three successive images of each triplet of images that can be formed from the sequence (see column 22, lines 39-42: The reference describes that the CPU 4 generates a list of points which are matched across all three images in the triple of images (i.e. establishing a set of triple matching points that depict the same point in the scene across the three successive images of each triplet of images that can be formed from the sequence).); establishing a first set of dual matching points that depict the same point in the scene across the latter two images of each triplet of images that can be formed from the sequence (see column 22, lines 39-42: The reference describes that points are established that match between each of the images in a triple of images. Therefore, these points also match across the latter two images of the triple of images and can be considered dual matching points.); and establishing a second set of dual matching

points that depict the same point in the scene in the first and third images of each triplet of images that can be formed from the sequence (see column 22, lines 39-42: The reference describes that points are established that match between each of the images in a triple of images. Therefore, these points also match across the first and third images of the triple of images and can be considered dual matching points.).

As applied to claim 14, which merely calls for a computer-readable medium having computer-executable instructions for performing the process performed by the system of claim 9, Davison et al. discloses such a computer-readable medium (see column 6, lines 16-18: The reference describes that operating instructions for the CPU 4 may be input from a removable data storage medium using disk drive 8.).

As applied to claims 15, 16, and 19, which merely call for the process performed by the system in claims 9, 10, and 12, since Davison et al. disclose the system, then the process performed by the system is also disclosed.

Claim Rejections - 35 USC § 103

6. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

7. Claims 7 and 8 are rejected under 35 U.S.C. 103(a) as being unpatentable over the combination of Davison et al. (U.S. Patent No. 6,668,082 B1) and Fitzgibbon et al. (the article titled "Automatic Camera Recovery for Closed or Open Image Sequences"). The arguments as to the relevance of Davison et al. in the rejection of claim 1 above are incorporated herein.

Claim 7 calls for the process action of estimating the camera pose parameters associated with the second image in the sequence, to comprise the action of using a two-view structure-from-motion technique.

Davison et al. does not disclose the use of such a technique for estimating the camera pose parameters.

However, Fitzgibbon et al., in the same field of endeavor of image processing and the same problem solving area of feature extraction, disclose the use of such a two-view structure-from-motion technique (see section 3.3, heading "Two-view overlap": The reference describes the use of a two-view overlap technique (i.e. two-view structure-from-motion technique) for estimating camera pose parameters.).

It would have been obvious to a person of ordinary skill in the art at the time the invention was made to modify Davison et al. by adding the use of a two-view structure-from-motion technique for estimating camera pose parameters as taught in Fitzgibbon et al. because the use of such a technique "has the advantage that shorter tracks are need – four views rather than five – and that any false inliers to the trifocal tensors may be identified because their tracks are inconsistent" (see Fitzgibbon: section 3.3, heading "Two-view overlap"). Therefore, the system can estimate the camera pose parameters using less information – four views rather than five – thus increasing processing speed.

Claim 8 calls for the process action of estimating the camera pose parameters associated with the second image in the sequence, to comprise the action of applying a global bundle alignment technique to the first three images of the sequence of images.

Davison et al. does not disclose the use of a global bundle alignment technique to estimate camera pose parameters.

However, Fitzgibbon et al., in the same field of endeavor of image processing and the same problem solving area of feature extraction, disclose the use of such a global bundle alignment technique (see section A, titled "Bundle Adjustment": The reference describes the use of bundle adjustment for estimating camera pose.).

It would have been obvious to a person of ordinary skill in the art at the time the invention was made to modify Davison et al. by adding the use of a global bundle alignment technique to estimate camera pose parameters as taught in Fitzgibbon et al. because the use of such a technique gives the system "the ability to quickly compute maximum likelihood estimates of cameras and structure (see Fitzgibbons et al.: section A, titled "Bundle Adjustment").

Allowable Subject Matter

8. Claims 2-6, 11, 13, 17, 18, 20, and 21 would be allowable if rewritten to overcome the objections under 37 C.F.R. 1.75 (a) set forth in this Office action and to include all of the limitations of the base claim and any intervening claims.

Claim 2, which is representative of claims 11, 13, 17, and 20 calls for the action of computing the camera pose parameters associated with the third image in the triplet under consideration which will result in a minimum value for the sum of the squared differences between the image coordinates of each identified triple match point and its corresponding predicted image coordinates in each of the three images in the triplet, added to the sum of the squared differences between the image coordinates of each identified dual match point and its corresponding predicted image coordinates in each of the latter two images in the triplet. These

claims describe "a specialized procedure for speeding up the processing associated with the present local bundle adjustment technique" (see applicant's specification: page 19, lines 4-6).

Conclusion

9. The prior art made of record and not relied upon is considered pertinent to applicant's disclosure.

Kumar et al. (U.S. Patent No. 6,597,818 B2) is pertinent in that the reference describes a system for mapping between image coordinates and geo-spatial coordinates (i.e. camera coordinates).

Shum et al. (the article titled "Efficient Bundle Adjustment with Virtual Key Frames: A Hierarchical Approach to Multi-frame Structure from Motion") is pertinent in that the reference discloses the use of bundle adjustment for the estimation of motion.

10. Any inquiry concerning this communication or earlier communications from the examiner should be directed to Ryan J. Miller whose telephone number is (703) 306-4142. The examiner can normally be reached on M-F 8:00-4:30.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Leo H. Boudreau can be reached on (703) 305-4706. The fax phone number for the organization where this application or proceeding is assigned is 703-872-9306.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

Ryan J. Miller
Examiner
Art Unit 2621

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